water by special tanks they could be deeply immersed and show only a small target above the surface when making an attack. There would be no necessity in such surface vessels to use electric motors and storage batteries, since internal combustion engines could be used in all circumstances. Hence it would be possible without increase of size to construct vessels of greater speed and radius of action, and to simplify designs in other important features. It is not possible to predict whether this suggestion to adopt surface-boats rather than submersibles will have a practical result; but it is unquestionable that improvements in or alternatives to internal combustion engines will favour the increase of power in relation to weight, and so will tend to the production of vessels of higher speed.

Submarines and airships have certain points of resemblance, and proposals have been made repeatedly to associate the two types, or to use airships as a means of protection from submarine attacks. One French inventor seriously suggested that a captive balloon attached to a submarine should be the post of observation from which information should be telephoned to the submarine as to the position of an enemy. He evidently had little trust in periscopes, and overlooked the dangers to which the observers in the car of the balloon would be exposed from an enemy's gun-fire. Quite recently a proposal has been made by M. Santos Dumont to use airships as a defence against submarines, his idea being that a dirigible airship of large dimensions and moving at a considerable height above the surface of the sea could discover the whereabouts of a submarine, even at some depth below the surface, and could effect its destruction by dropping high explosive charges upon the helpless vessel. Here again, the inventor, in his eagerness to do mischief, has not appreciated adequately the risks which the airship would run if employed in the manner proposed, as submarines are not likely to be used without supporting vessels. Hitherto, submarines themselves have been armed only with torpedoes, but it has been proposed recently to add guns, and this can be done, if desired, in vessels possessing relatively large freeboard. No doubt if gun armaments are introduced, the tendency will be further to increase dimensions and cost, and the decision will be governed by the consideration of the gain in fighting power as compared with increased cost. As matters stand, submarines are practically helpless at the surface when attacked by small swift vessels, and it is natural that advocates of the type should desire to remedy this condition. Surface boats, if built, will undoubtedly carry guns as well as torpedoes, and in them the gun fittings would be permanent, whereas in submarines certain portions of the armament would have to be removed when vessels were prepared for diving.

Apart from the use of submarine vessels for purposes of war, their adoption as a means of navigation has found favour in many quarters. Jules Verne, in his "Twenty Thousand Leagues Under the Sea," has drawn an attractive picture of what may be possible in this direction, and others have favoured the idea of combining the supposed advantages of obtaining buoyancy from bodies floating at some depth below the surface with an airy promenade carried high above water. Not many years ago an eminent naval architect drew a picture of what might be accomplished by utilising what he described as the "untroubled water below" in association with the freedom and pure air obtainable on a platform carried high above the waves. These suggestions, however, are not in accord with the accepted theory of wave-motion, since they take no note of the great depths to which the disturbance due to wave-motion penetrates the ocean. The problems of stability, incidental to such plans, are also of a character not easily dealt with, and consequently there is but a remote prospect of the use of these singular combinations of submarine and aërial superstructures. There is little likelihood of the displacement of ocean steamships at an early date by either navigable airships or submarines, and the dreams of Jules Verne or Santos Dumont will not be realised until much further advance has been made in the design and construction of the vessels they contemplate.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of the Institution of Mechanical Engineers was held last week in Belgium. The opening proceedings took place in the city of Liége, the president, Mr. E. P. Martin, occupying the chair at the preliminary sitting. Six papers were down for reading and discussion, the mornings of June 20 and June 21 being devoted to their consideration. The following is a list of the papers:—Superheaters applied to locomotives on the Belgian State railways, by M. J. B. Flamme; the growth of large gas-engines on the Continent, by M. Rodolphe Mathot; ferro-concrete, and some of its most characteristic applications in Belgium, by M. Ed. Noaillon; electric winding machines, by M. Paul Habets; strength of columns, by Prof. W. E. Lilly; an investigation to determine the effects of steam-jacketing upon the efficiency of a horizontal compound steam engine, by Mr. A. L. Mellanby.

The first paper taken was the contribution by M. Flamme on superheating for locomotives. The author first dealt with the Schmidt superheater for simple expansion locomotives as applied on the Belgian State railways. Arrangements were made for superheating the steam, in order further to increase the power of the engines. As a result of experiments made, extending over some months, it was recognised that the utilisation of steam slightly superheated did not offer any appreciable economy of fuel or increase of power. On the other hand, with the Schmidt apparatus, when the steam was superheated from 570° F. to 662° F., favourable results were obtained. Two engines were tried, one using superheated steam and the other saturated steam. The saving in favour of the superheated steam locomotive amounted to 12·5 per cent. for fuel and 16·5 per cent. for water. Moreover, the speed reached showed an average increase of 9·5 per cent., all conditions being exactly the same. In regard to maintenance, the superheated steam locomotive type did not require special attention during its one and a half years' service. These favourable results led to the Belgian State railways venturing on the application of superheat to locomotives on a larger scale. With this in view, twenty-five locomotives, comprising five different types, all provided with the Schmidt superheater, were, at the time of the reading of the paper, actually in course of construction, or were about to be put to work. The Belgian State railway authorities had decided to persevere in their experiments in combining superheating of steam with compounding of the engine. The results obtained will be of very great interest. It was desirable to find whether it was more economical to divide the superheater into two parts in such a manner as to raise the temperature at the entrance to both high-pressure and low-pressure cylinders. The Cockerill Co., of Seraing, had completed a superheater which would enable this question to be settled.

The discussion on this paper was opened by Mr. Robinson, of Messrs. Sharp, Stewart, and Co., who stated that the Schmidt superheater had been tried on the Canadian Pacific Railway, and had been found to answer, whilst on the Cape railways the results had not been so satisfactory. He attributed the latter effect to the fact that the superheating tubes were placed at the lower part of the barrel of the boiler, instead of at the upper part as they should have been. Mr. Mark H. Robinson and the president also spoke.

The next paper taken was that of Mr. Paul Habets on electric winding machines. This was a long and somewhat abstruse paper, illustrated by many diagrams, and containing a large number of formulæ. It was read in brief abstract by the secretary of the institution. The author gave a dynamic investigation of haulage, dealing with the questions of resistance, statical moments, inertia of suspended loads, inertia of rope-roll, the head gear and winding gears of motors, and other elements of design. Formulæ were given for moments of the accelerating forces and power and expenditure of energy. Details of construction of motors were discussed, and some special devices explained. As a practical conclusion, the author stated that it might be safely concluded from trials of which particulars were given that the electric haulage machine,

even if it were not more economical than the best steam-driven machines, was certainly not more expensive. The greater facility and safety with which electricity can be used, the smoothness with which it works, and its much greater flexibility, would often make it preferable to the use of steam, even in a case where transmission of energy was not required; there could be no hesitation in the choice between the two systems when the power had to be transmitted from a distance, or where the production of energy could be centralised at one power station.

M. Ed. Noaillon's paper on ferro-concrete was next read. Ferro-concrete constructions, as is well known, consist of a mass in which iron or steel reinforcement is bedded. The author stated that round bars were generally used, as they facilitated the escape of air and the proper ramming of the concrete; there were also no sharp angles which would cut the concrete. On the other hand, the round section gave the lowest coefficient of adhesion for a given cross-section of metal. The following rules governing the construction had been prepared by Prof. Rabut:—(1) No connection should be made of iron to iron, as the concrete itself holds the parts together in the most economical manner. (2) At least two distinct systems of reinforcement should be used, one to take up the tensile stress and the other to take up the shearing stresses in the concrete; when necessary a third system should be used to take up the compressive stresses. (3) The reinforcement should be so arranged that the separate members may be stressed in the direction of their length, so that the stresses produced between the iron and the concrete should be tangential, and not normal to the axis of the members of the reinforcement. (4) Homogeneity of the structure should be taken advantage of by prolonging the iron parts of one portion of the structure into the thickness of the concrete of the adjoining portion. Other points were also given.

Methods of construction were described and illustrated. Some examples of reinforced concrete were given in the paper, the handsome dome of the new Central Railway Station at Antwerp being a prominent instance. This dome is a fine piece of architecture, but was designed first of all for an ordinary masonry structure, a fact which made it somewhat difficult for the architects to adapt it for ferro-concrete. The entire structure is 1800 tons in weight, and rests wholly upon the columns at the angles of the glass lights; these columns are Y-shaped in cross-section. The external shell has a uniform thickness of 3·15 inches, and is relieved by six moulded ribs following the meridian lines. The Renommée Hall at Liége was the next example of this kind of construction. It was designed expressly for the use of this material. The principal hall is covered by three cupolas, each 55 feet in diameter, placed at a height of about 50 feet above the level of the ground. Each cupola forms part of a sphere, which continues in haunches, pierced with lights, and descending to the corners of the circumscribed square. The intersections of the spheres with the vertical spans passing through the sides of the squares are formed by arched beams, which spring from the capitals of short cylindrical columns. The cupolas are $4\frac{1}{2}$ inches thick, and are made of concrete composed of cement clinker finely broken up; they are reinforced by a layer of expanded metal with a lattice work of bars. Members of the institution had a good opportunity to examine this structure, as one of the banquets during the meeting was given in the Renommée Hall.

An interesting application of reinforced concrete was also described in the widening of La Boverie Bridge at Liége. Particulars were also given of another bridge, built upon the Hennebique system; the length between abutments was 260 feet, and comprised a central span of 180 feet and two side spans. The total width of the roadway was 32·8 feet. An interesting feature about this bridge is the design of the foundations, and the way they were erected by mechanical compression of the soil. The piers and abutments rested upon a group of concrete piles driven deeply into the bed of the gravel, which thus became strongly compressed. The concrete piles were reinforced by vertical bars of steel which were continued into the piers and abutments, so that the whole was solidly bound together. By this method the advantage was obtained of solidly rooting the bridge into the earth, so that it had a resistance amply sufficient in case of a floating accumulation of ice, such as would temporarily transform the bridge into a dam. A skew bridge, also on the Hennebique system, was referred to, and a description was also given of a framework for lead chambers at the chemical works of the Engis Co. In the brief discussion which followed this paper, Mr. W. H. Maw suggested that it would be interesting if experiments could be made upon the effect of tension upon bars held in concrete. He had heard that a better hold of the concrete was obtained if the bars were previously treated to a wash of cement.

Mr. Mellanby's paper on the efficiency of the steam jacket was next read. This paper may be said to form part of a series of contributions on the same subject which have been given by various authorities during recent times. The results of a series of somewhat elaborate trials were given, from which the following general results may be taken. A compound engine, with boiler pressure at 150 lb., may be worked with the mean pressure referred to the low-pressure cylinder of about 40 lb. per square inch without any loss of efficiency in terms of the brake horse-power. Steam jackets have their maximum efficiency when the whole of the high-pressure and the ends of the low-pressure cylinders are jacketed with high-pressure steam. When jackets are applied to the high-pressure cylinder, the total indicated horse-power is slightly reduced, but when applied to the low-pressure cylinder the total indicated horse-power is considerably increased. Jackets have little effect in the high-pressure, but have considerable effect in the low-pressure cylinder upon initial condensation. The temperature supplied to the cylinder walls next to the steam must be considerably less than that of the steam, because, firstly, the actual "missing quantity" is much less than it would have been had the steam and metal gone through the same temperature changes, and secondly, because the mean temperature of the metal is higher than that of the steam. The author concluded that the greater part of the "missing quantity" must be due to leakage, and not to initial condensation, in this respect agreeing with the conclusions of Messrs. Callendar and Nicolson.

A somewhat extended discussion followed the reading of this paper. It was opened by Mr. V. Pendred, who said that compression in the cylinder had a considerable effect. If the compression corner of the indicator diagram was square, the utility of the jacket appeared to be small, but if it were rounded off by compression jacketing appeared to be more effective. Mr. Saxon, of Manchester, took exception to the statement as to a mean effective pressure of 40 lb. being the most efficient for a compound engine he considered that the ratio of the cylinders should be taken into account. Mr. Henry Davey did not regard the results obtained as a guide for engineers, on account of the bad performance of the engine. Mr. Mark Robinson confirmed the author's opinion in regard to a mean pressure of 40 lb., and, in reply to a remark of Mr. Saxon's, said that the size of the cylinders should be in accordance with the power needed, and their ratio should be governed by the conditions of working.

On the second day of the meeting the first paper taken was a contribution by Mr. R. Mathot on large gas-engines. This was a long and interesting paper, containing a considerable amount of historical matter, and dealing with many of the details of construction by Continental makers in the design of large gas-engines, which have formed so prominent a feature of the engineering of Germany and Belgium within the last few years. The paper was illustrated by a number of engravings and diagrams, and results of engine tests were given in a table. Although English engineers early took the lead in the manufacture of gas-engines of moderate size, they have been to some extent left behind by Belgian and German manufacturers in regard to large gas-engines using blast-furnace gas; and even such of the latter as have been constructed in England have been mostly to German designs. It would be impossible in a report of this nature to give an account of the many details of construction dealt with by the author, especially without the aid of the numerous illustrations by which the paper was accompanied.

The discussion that followed the reading of the paper mainly consisted of a speech by Mr. Crossley, of Man-

chester, who defended the position of the English gas-engine makers, pointing out what had been done in the past. He did not, however, deny that the Continental makers were in advance of the English makers in regard to the size of the gas-engines manufactured.

The remaining paper was Prof. Lilly's contribution on the strength of columns, but the time for adjournment having arrived, this was only read in brief abstract, and was not discussed.

A large number of excursions and visits to works in the neighbourhood of Liége had been arranged by the local committee. Visits were also paid to the exhibition, and there were the usual social functions, including the reception, the dinner at the Renommée Hall already mentioned, and the institution dinner held at Liége. Thursday was entirely given up to these excursions, and on Friday members travelled to Antwerp, where they viewed the extensive docks of that city and some of the works in the neighbourhood. This brought a very successful meeting to a close.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. Ritchie, Fellow of New College, the present reader in pathology, has been constituted professor of pathology so long as he continues as reader. Dr. A. J. Herbertson, non-collegiate, has been appointed university reader in geography.

The Rev. H. T. Morgan, Trinity College, has offered to continue the unfinished carving in the corridors of the university museum. Much of the elaborate plan for the sculptural decoration of the museum, undertaken in 1860, has remained uncompleted, and the Rev. H. T. Morgan has generously undertaken to provide for the carving of the capitals and corbels of at least two of the four upper corridors. The delegates propose to continue the original plan, according to which the capitals were to represent various plants in systematic order.

On June 20 a deputation from the medical graduates of the university, Sir William Church, Dr. Sharkey, Dr. Shornstein, Dr. Collier, and Mr. Whitley, presented an address to the Vice-Chancellor urging the importance of pathology in the medical curriculum of the university, and stating the steps that have been taken to provide permanent endowment for the teaching of this subject. A "pathology endowment fund" has been started, and an appeal that was limited to members of the profession has resulted in the contribution of more than 500*l*. A member of the university, who has already given 1000*l*. towards the endowment of a pathology chair, has offered to cover all subscriptions from the medical faculty by an equal amount.

IT is announced that General W. J. Palmer, of Colorado Springs, Col., and Mr. Andrew Carnegie have given respectively 20,000*l*. and 10,000*l*. as a nucleus to the 100,000*l*. endowment fund for Colorado College.

MR. T. P. BLACK has been appointed demonstrator in physics in Armstrong College, Newcastle-upon-Tyne. Mr. Black was a student of the college from October, 1900, to June, 1903, when he was elected to one of the Royal (1851) exhibition scholarships.

WE learn from *Science* that the proposed affiliation of the Massachusetts Institute of Technology with Harvard University was approved at a meeting of the corporation of the institute on June 9. It was agreed to accept the terms of the agreement recently drawn up by the committee of the two institutions. Before the agreement can become effective the corporation and overseers of Harvard University must take action, and several legal questions must be settled.

THE committee appointed to inquire into the present condition of fruit culture in Great Britain, and to consider whether any other measures might with advantage be taken for its promotion and encouragement, has reported to the Board of Agriculture in favour of the establishment of a special sub-department to deal with matters connected with the fruit industry. The main recommendation is that there should be two branches of such sub-department—(*a*) a bureau of information, (*b*) an experimental fruit farm. It is further proposed that horticulture should be taught in elementary schools in country districts, that such schools should have gardens attached wherever possible, and that the attention of local education authorities should be directed to this, and also to the desirability of encouraging the study of practical horticulture in training colleges.

THE programme of the summer meeting of university extension students, which is to be held at Oxford in August, has now been published. The lectures in the natural science section will be devoted to an explanation of the scientific method and to the illustration of its application to scientific work. General introductory lectures will be delivered by Prof. T. Case, on the scientific method as an operation of the mind, and by Prof. F. Gotch, F.R.S., on the development of the scientific method. Special lectures illustrative of the applications of the scientific method to numerous branches of science have been arranged, and these lectures will be directed to show the extent to which the general conception of the particular science has been developed by the use of the scientific method, and the way in which the method is used in the experimental investigation of some group of phenomena. Among the varied list of lectures from which students may choose we notice those by Prof. W. F. R. Weldon, F.R.S., on variation and heredity; by Prof. C. S. Sherrington, F.R.S., on a general survey of physiology and psychophysics; by Prof. W. M. Flinders Petrie, F.R.S., on crucial instances in archæology; and by Dr. G. J. Burch, F.R.S., on modern conceptions of matter.

MR AILWYN FELLOWES, President of the Board of Agriculture, presided at an agricultural conference held at Aberystwyth last week. The object in view in holding the meeting was the extension and development of the work of the agricultural department of the University College of Wales by the establishment of a more definite connection between its extension work and that done inside the college, and by better organisation of the department of agriculture itself. Mr. Fellowes said that the Board of Agriculture has been able to give 800*l*. a year to Aberystwyth College and 200*l*. a year towards the college farm which was opened the same day. The college is also largely aided by the residue grant which since the year 1890 has been handed over to the county councils of the kingdom. In the counties connected with Aberystwyth College, one-sixth of the residue grant has been given to agricultural education. Mr. Fellowes said he hoped, as time went on and as Imperial funds improved, that the Board of Agriculture will be able to do more for agricultural education and for agricultural colleges. He strongly commended the suggestion that a descriptive pamphlet should be issued by the college authorities setting forth what are the proceedings of the college and what young men are able to learn there. It was decided to ask the county councils to appoint representatives to consider the details of a scheme of organisation for the agricultural department at a conference to be held in October. The following resolution was passed:—that this conference desires to record its warm gratitude to the Board of Agriculture for the invaluable aid it has rendered to agricultural education in the counties affiliated to the University College of Wales at Aberystwyth. The conference is of opinion that the results already attained and the response to the help and guidance received from the Board by the local authorities out of their limited resources constitute a strong claim for largely increased grants from the central Government towards agricultural education, which is a matter of the highest importance in the interests of the kingdom and the Empire at large. In the afternoon Mr. Fellowes opened the recently acquired college and counties' training farm, which is situate about four and a half miles outside Aberystwyth, and has an area of 200 acres.